Lidar Report

for

Wayne Co, GA

Contract Number: G10PC00026
Task Order: G10PD00654

PHOTO SCIENCE
Geospatial Solutions

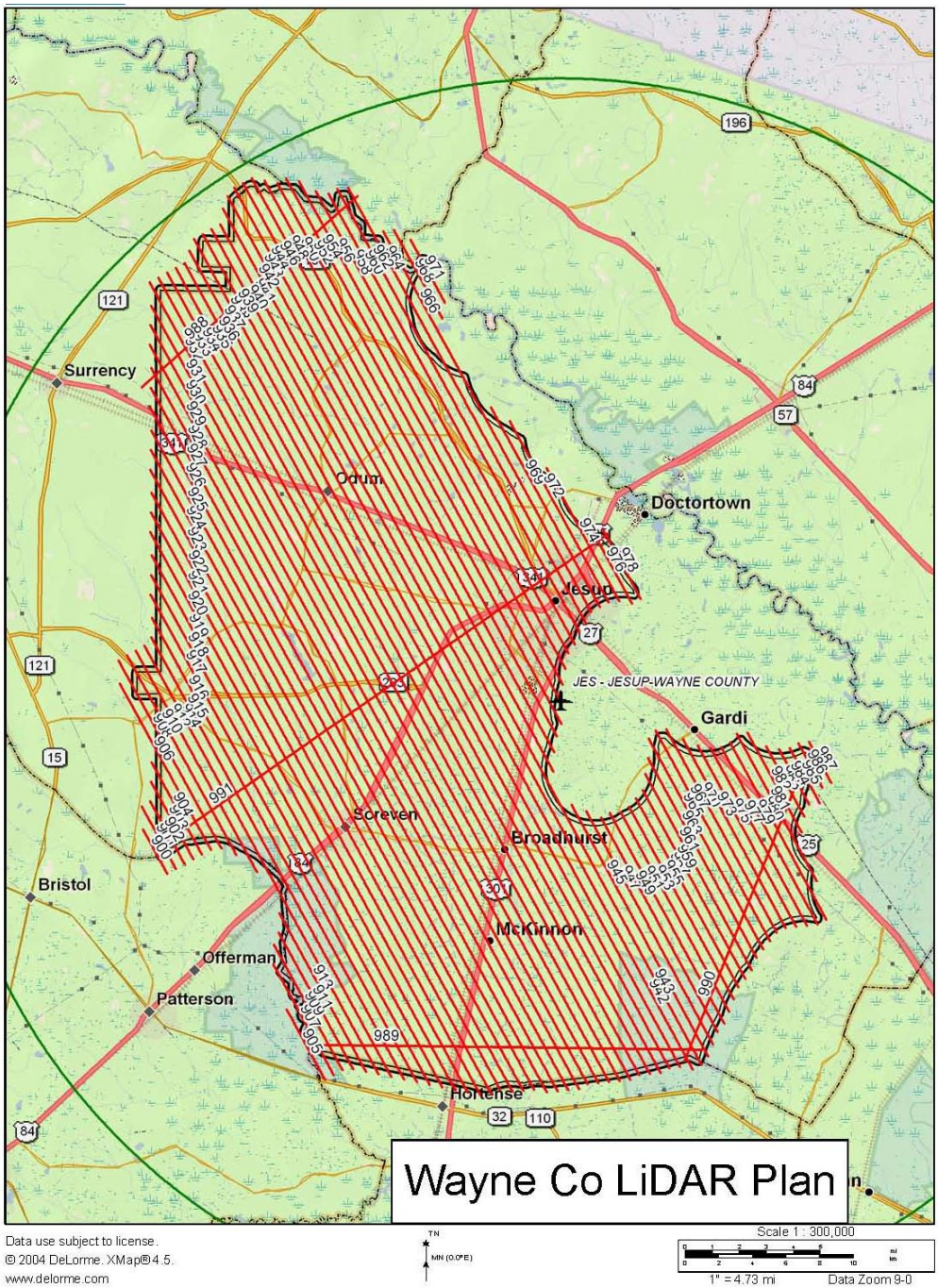
May 4, 2010

Table of Contents

List of Appendices (Reference Included Files)

Project Description

The purpose of this project is to provide professional surveying and mapping services for the creation of a high-resolution digital elevation model developed from LIDAR data for Wayne County, Georgia. The project area is shown in the graphic below.



Aerial Platform / Lidar Sensor

All flights for the project were accomplished with customized single-engine Cessna 206s which provide an ideal, stable aerial base for Lidar acquisition. This platform has relatively fast cruise speeds that are beneficial for project mobilization / demobilization while maintaining relatively slow stall speeds which can prove ideal for collection of a high-density, consistent data posting.

Photo Science utilized both of our Optec Gemini LiDAR scanners on this project to date. Both systems are capable of collecting data at a maximum frequency of 167 kHz, which affords elevation data collection of up to 167,000 points per second. The system utilizes a Multi-pulse in the Air option (MPIA). This sensor is also equipped with the ability to measure up to 4 returns per outgoing pulse from the laser and these come in the form of 1st, 2nd, 3rd, and last returns. The intensity of the first three returns is also captured during the aerial acquisition.

See appendix C for system calibration information

Flight Parameters

Detailed project planning was performed for this project. This planning was based on project specific requirements and the characteristics of the project site. The basis of this planning included the required accuracies, type of development, amount and type of vegetation within the project area, the required data posting, and potential altitude restrictions for flights in the general area. A brief summary of the aerial acquisition parameters for this project are shown in the table below:

Area Flight Profile

Total Length:	2,219.588 km
Flight Tim:	16:17:24
Laser Time:	09:59:14
Swath Area:	1,487.368 km^2
AOI Area:	1,282.241 km^2
Altitude:	6000 ft AGL
Speed:	120 kts
Flight Lines:	57
Pass Heading:	331
Pass Spacing:	670.11 m
Overlap:	40% = 446.736 m
Turn Time:	6 min

Area LIDAR Settings

Desired Res:	0.983 m
Density:	1.03 ppm^2
Cross Track Res:	0.983 m
Down Track Res:	0.983 m
Scan Frequency:	31.4 Hz
Scan Angle:	+/- 17 deg
Scan Cutoff:	+/- 0.02 deg
Scan Offset:	0 deg
System PRF:	71.429 kHz
Swath Width:	1,116.84 m

Reference the Aeroplan sensor summary information included in Appendix D.

Dates Flown

Collection occurred as weather permitted between the period of March 19th, 2010 through March 27th, 2010. Three lifts were flown (March 19th, 20th, 27th).

Reference the flight logs and trajectory files included in Appendix B & E for graphical depictions and reports for each mission.

Flight Line Layout

As depicted above, a total of 57 flight lines totaling 2,219.588 km flight line miles were required to cover the project area.

File Information

2000x2000 meter tiles are delivered as LAS, DEM, Intensity Images, and ARC Exchange Files. The file naming schema is based on the lower left hand corner of each tile, based on a 5,000ft x 5,000ft format. The deliverable formats for the files are in the table below:

- LAS (594 – LAS Version 1.2 files)
- Raster DEM (594 – 3.125' DEM files in ERDAS IMG format)
- Intensity Images (594 – GeoTIFF Images in TIF/TFW Format)
- ARC Exchange Files (594 – TIN files in E00 format)
- Hydro Flattened Breaklines (1 – Arc Shapfile format)
- Raw Flight Line Source (66 – LAS Files in 8 folders)

Projection / Datum

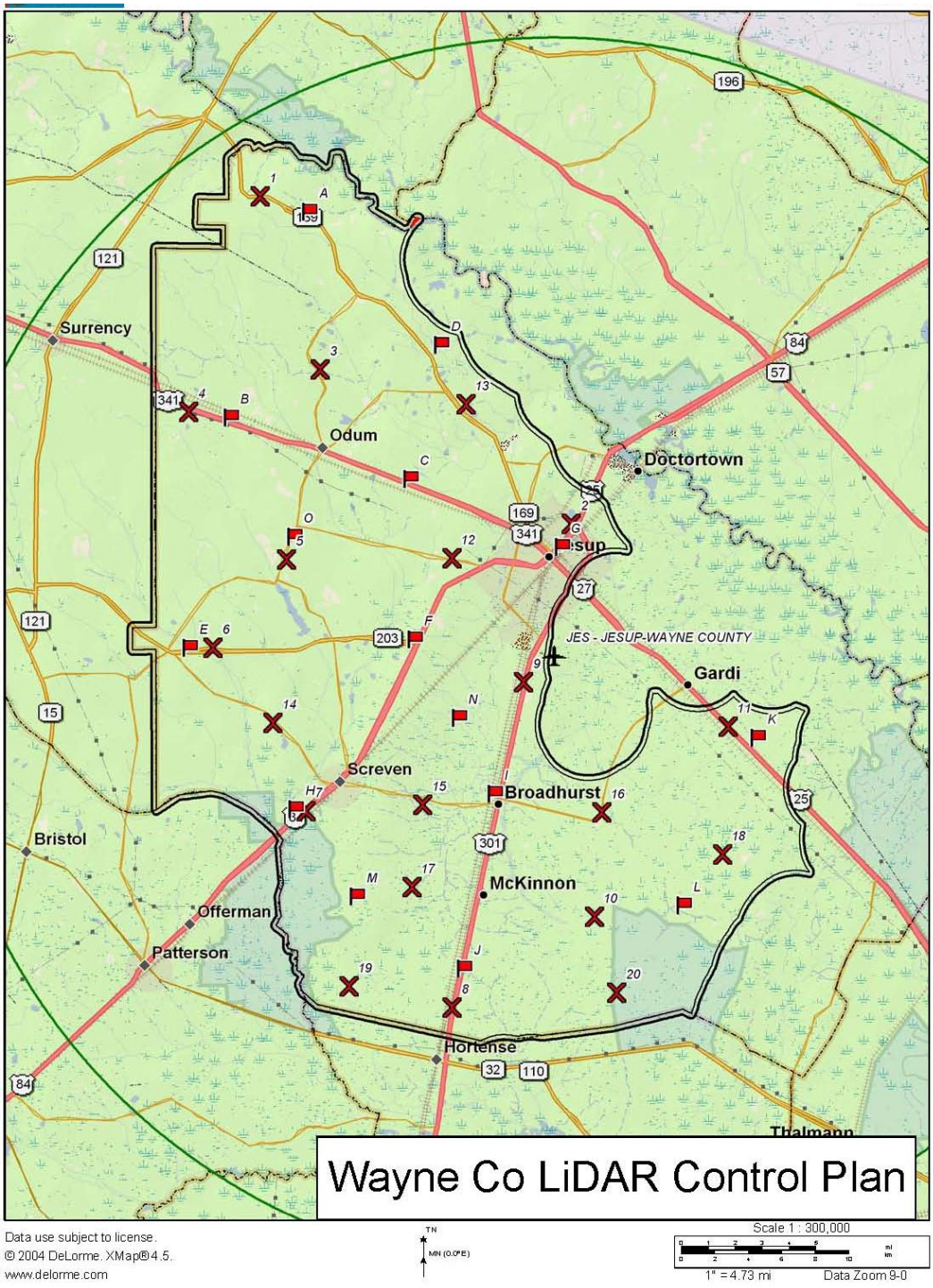
All data for this project were reduced to Georgia State Plane Coordinate System using NAD1983, US Survey Foot (FIFPS 1001). All elevations were presented as orthometric heights using NAVD88 – Geoid09, US Survey Foot.

Base Stations Used

ABGPS stations were performed using Trimble 5700 data collection units, logging at 2 hertz, paired with Trimble Zephyr Geodetic antennas, which were mounted on variable height tripods with the H.I. measured at the beginning and end of each logging session.

The overall study area utilized a base station as described below. The station was located at the JES Airport, Wayne County, GA. The figure below depicts the base station and additional control locations in relation to the project area.

See Appendix F for CORS station values.



There are several limiting factors to LiDAR data collection which include:

Weather: there can be no clouds, excess moisture (rain, fog or excessive humidity) between the sensor and the ground we are profiling. Additionally, high winds which if blowing perpendicular to the line of flight could provide for excessive crab resulting in "slivers" or "holidays" between flight lines as well as unsafe flight conditions such as wind shear or clear air turbulence.

Ground Conditions: Such as standing water from recent heavy rains, excessive "ponding" or "pooling" of water which will affect the accuracy of the LiDAR returns as will snow and Ice. This is especially apparent in ditches with high water and along roadways and fence lines with drifting snow.

Satellite Configuration: Typically one does not want to collect LiDAR during time of high PDOP, this is due to the GPS configuration providing accuracy less than desired. For this project there is to be no data collection during periods of PDOP above 3.5 or periods with less than 6 visible satellites. To these ends, PDOP was checked each morning with a fresh almanac and newly updated satellite health status from the US Coast Guard Navigation Center website.

GPS Collection Parameters

Collection parameters for this project included the following:

Parameter	Value
Maximum PDOP	3.5
Minimum number of SVs	6
Ground collection epoch	2 Hz (0.5 sec)

Data Processing

Optech software was used in the post-processing of the airborne GPS and inertial data that is critical to the positioning of the sensor during all flights. This software suite includes Applanix's PosPac and Waypoint's GrafNav solutions. PosPac provides the smoothed best estimate of trajectory (SBET) that is necessary for Optech's post processor to develop the point cloud from the Lidar missions. The point cloud is the mathematical three dimensional collection of all returns from all laser pulses as determined from the aerial mission. At this point this data is ready for analysis, classification, and filtering to generate a bare earth surface model in which the above ground features are removed from the data set.

The point cloud was created using Optech's Post Processor software. GeoCue was used in the creation of some of the files needed in downstream processing,

as well as in the tiling of the dataset into more manageable file sizes. The TerraScan and TerraModeler software packages are then used for the automated data classification, manual cleanup, and bare earth generation from this data. Project specific macros were used to classify the ground and to remove the side overlap between parallel flight lines. All data was manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler. QT Modeler was used as a final check of the bare earth dataset. GeoCue was then used to create the deliverable LAS 1.2 files for both the All Point Cloud Data and the Bare Earth. In-house software was then used to perform final statistical analysis of the classes in the LAS files.

QA/QC Analysis

A total of 20 points in three different land cover types (bare earth, tall grass, and urban) were established in the field for check points assessing the accuracy of the Lidar surface. Two points in open areas over existing NGS benchmarks were established. The table below lists the statistics of this analysis of the QC (blind points):

Statistical Analysis	
Average Dz	0.02
Minimum Dz	-0.242
Maximum Dz	0.361
RMSE	0.19
Standard Deviation	0.195

Coordinate System
Horizontal Projection
NAD1983 - Georgia East State Plane, US Survey Foot (FIPS 1001)
Vertical Datum
NAVD88 - Geoid09, US Survey Foot

Point	Easting	Northing	Known Z	LIDAR Z	Dz
1B	687459.69	655559.00	181.36	181.25	-0.11
2B	673609.25	613433.93	161.71	161.97	0.26
3B	698407.33	621160.16	149.61	149.68	0.07
4B	728331.43	615107.38	138.83	138.86	0.03
5B	691254.19	583647.64	142.40	142.68	0.28
6B	724068.79	583593.93	147.14	146.94	-0.20
7B	748875.48	590704.78	62.22	61.98	-0.24
7B-2	695985.48	534881.86	99.37	99.38	0.01
8B	678002.80	566411.92	120.99	121.16	0.17
9B	689289.99	552160.76	128.62	128.72	0.10
10B	739007.55	560071.29	96.26	96.13	-0.13
12B	718760.40	537621.17	67.88	68.24	0.36
13B	754233.33	534716.73	59.63	59.69	0.06
14B	778983.87	551404.69	74.14	73.94	-0.20
15B	720025.88	518502.49	60.27	60.17	-0.10
16B	752889.46	514209.69	57.81	57.91	0.10
17B	787895.95	527526.04	80.85	80.61	-0.24
18B	704143.63	500107.70	63.19	63.01	-0.18
19B	725347.36	496753.11	59.27	59.18	-0.09
20B	756998.10	494489.32	76.79	77.13	0.34

In addition to the quality control points collected, the following production field control was utilized for this project:

Statistical Analysis	
Average Dz	-0.03
Minimum Dz	-0.397
Maximum Dz	0.263
RMSE	0.177
Standard Deviation	0.181

Coordinate System
Horizontal Projection
NAD1983 - Georgia East State Plane, US Survey Foot (FIPS 1001)
Vertical Datum
NAVD88 - Geoid09, US Survey Foot

Point	Easting	Northing	Known Z	LIDAR Z	Dz
1C	692548.57	652229.79	176.87	177.13	0.26
2C	681690.90	610641.71	157.84	157.98	0.14
3C	722370.44	623375.14	121.55	121.59	0.04
4C	712072.04	600323.03	144.26	144.26	0.00
5C	669748.20	565807.90	147.55	147.49	-0.06
6C	713461.42	568278.79	104.54	104.70	0.16
7C	745150.56	585069.91	93.64	93.48	-0.16
8C	693660.15	533122.74	86.53	86.40	-0.13
9C	732985.26	536334.87	56.27	56.41	0.14
10C	783432.26	547058.62	82.10	81.70	-0.40
11C	702459.36	515425.46	100.07	100.02	-0.05
12C	726537.83	502229.34	62.26	62.05	-0.21
13C	776664.13	516937.19	77.44	77.30	-0.14

Problems Encountered

Problems encountered during this project were minimal. There were times of clouds, which is to be expected in a coastal environment. There were also a few times with winds outside what we consider an acceptable range. High cross winds result in crab and can minimize the overlap between adjacent flight strips. There were also some times with less than acceptable GPS configuration in terms of high PDOP or less than 6 satellites available for tracking. The crew checked the expected GPS configuration daily along with the weather and did not fly during less than ideal times. No issues were documented in the LAS tile development phase of production.

Appendix

Appendix A: Survey Report *(Ref: Wayne_Co_GA_Survey Report_G10PD00654 directory)*

Appendix B: Logs *(Ref: Wayne_Co_GA_Control_G10PD00654 Directory)*

Appendix C: System Calibration Reports *(Ref: Wayne_Co_GA_System_Calibration_Report_G10PD00654 directory)*

Appendix D: Aeroplan Sensor Report *(Ref: Wayne_Co_GA_Aeroplan_G10PD00654 directory)*

Appendix E: Trajectory Report by flight date *(Ref: Wayne_Co_GA_Trajectory Report_G10PD00654 directory)*

Appendix F: CORS and Base Station Reports *(Ref: Wayne_Co_GA_CORS & Base Stationing_G10PD00654 directory)*